This is not a peer-reviewed article.

Paper Number: 024070
An ASAE Meeting Presentation

Feeding Behaviors of Laying Hens with or without Beak Trimming

K.E. Persyn[1] H. Xin, Ph.D. [2] A. Ikeguchi, Ph.D. [3] R.S. Gates, P.E., Ph.D.[4]

[1]Research Assistant, Agricultural and Biosystems Engineering Department
Iowa State University, Ames, IA 50011-3080, U.S.A

[2]Professor, Agricultural and Biosystems Engineering Department
Iowa State University, Ames, IA 50011-3080, U.S.A

[3]Senior Researcher, Headquarters, Research Strategy and Survey Section
National Agricultural Research Organization
Tsukuba city, Ibaraki-ken, 305-8666, Japan

[4]Professor, Biosystems and Agricultural Engineering Department
University of Kentucky, Lexington, KY 40546-0276, U.S.A

Written for presentation at the
2002 ASAE Annual International Meeting / CIGR XVth World Congress
Sponsored by ASAE and CIGR
Hyatt Regency Chicago
Chicago, Illinois, USA
July 28-July 31, 2002

Abstract. *This study quantifies feeding behavior of the W-36 White Leghorn laying hen (77-80 weeks old) as influenced by the management practice of beak trimming. The feeding behavior is characterized by a newly developed measurement system and computational algorithm. Non-trimmed (NT) and beak trimmed (BT) birds showed similar meal size. BT birds spent longer time at the feeder, which is compatible to their slower ingestion rate of 0.9 g/min vs. 1.3 g/min of the NT type. Compared with NT bird, the BT bird had smaller time intervals between meals, 200 vs. 450 s. By scientifically characterizing the feeding behavior of laying hens, baseline information will result that may help better quantify the welfare of birds.*

Keywords. Animal well-being, Beak trimming, Behavior, Feeding, Poultry, Welfare

Introduction

The assessment of animal well-being should engage available scientific evidence concerning the feelings of the animals that can be derived from their structure, functions and behavior (Brambell, 1965). These response assessment criteria include a need for sensitivity to all stimuli, responsive over different time periods and levels of stimulus, and suitable repeatability for scientific assessment (Gates and Xin, 2001). Although many stimuli need to be included to evaluate well-being it is necessary to analyze the characteristics in individual studies to gain a better understanding of each characteristic's effect on the animal. The compilation of fundamental data can then be used for management practices to possibly improve the welfare of animals.

The feed trough is a major attraction for laying hens and the time spent manipulating feed probably reflects the degree of behavioral activation experienced by a hen (Webster and Hurnik, 1992). In the past video imaging has been used to monitor feeding behavior of laying hens. However, this methodology is time-consuming, costly, tedious and prone to errors (Gates and Xin, 2001). By using the measurement system and computational algorithm developed by Xin and Ikeguchi (2001, unpublished report), feeding behavior of poultry can be quantified, including the number of meals, meal size, meal duration, ingestion rate and meal intervals. Collection of such behavioral information represents an attempt toward searching for an objective, quantitative, and non-invasive means to measure animal welfare, which continues to challenge the academic community and the animal industry alike. The objectives of this research were to refine a measurement system and analytical algorithm for characterizing feeding behaviors of poultry and to investigate the effects of beak trimming on feeding behavior of laying hens as related to animal welfare.

Literature Review

Bernard Rollin's work and opinions, as stated by CAST (1997), claim that in animal agriculture in the United States, business priorities still often prevail over emerging ethical considerations. He also gives the opinion that in view of the nature of our economic systems, politics, and governance, this will probably be the case so long as assessment of animal well-being is based on no science, inadequate science, or lack of interest. This point is also shared by Gomes (1993). However, Rollin believes that today, the problem is primarily that of inadequate science.

The intensive production systems most criticized in the United States are the caged laying hens, confinement swine production, and white veal systems (Becker, 1992). Improper beak trimming procedures can result in permanent damage to overall flock performance (Christensen, 1984). Too much heat from the trimming blade may result in over burning of the beak; too little heat may result in excessive bleeding (Christensen, 1984). Chronic pain may be associated with the feed intake following beak trimming (Duncan, 1992; Gentle et al., 1990; Cunningham, 1992, Dunnayer, 2001). However, the argument can be made that although animals are feeling "something" this does not translate into an experience anything similar to a human being with feelings of fright, frustration, or pain (Dunnayer, 2001).

White Leghorn stocks have been identified as having a high propensity for feather pecking and cannibalism (Swanson, 1995). The Hy-Line W-36 pullet is most successfully beak trimmed between 7 and 10 days of age. The chicks are trimmed 2 mm from the nostrils by a cherry red blade that is recommended for proper cautery (Hy-Line, 2001). It is suggested that immediately after trimming to increase the depth of the feed in the pans or troughs to encourage the birds to eat and to prevent additional stress caused by the beak tenderness (Christensen, 1984). Spring and summer beak trimmed broiler chicks evaluated at 42 days of age had lower overall weight, feed intake, and higher mortality rate than untrimmed control chicks. Deaton (1988) explained that beak trimming of mash-fed roasters even at 56 days of age had a significantly reduced body weight gain and feed consumption as compared to the untrimmed controls. However, from 56 to 70 days old, beak trimming did not significantly affect weight gain or feed consumption.

Beak trimming is considered a necessary management practice in the poultry industry to prevent cannibalism and reduce social stress among birds (Lee and Craig, 1991). Beak trimming of pullets has a generally beneficial effect in reducing mortality in cages (Duncan, 1992; Lee and Craig, 1991). Some people view trimming as a cruel mutilation that should be stopped, the physical damage that untrimmed birds can inflict on penmates is a real problem (Struwe et al., 1992). Pecking problems not only have serious effects for the birds, but also for the economy of the farm (Dutch Society for the Protection of Animals, 1996). Struwe et al. (1992) reported that at 21 wk of age, both the heart and adrenal weights were significantly greater ($P<0.05$) in the untrimmed group than in the other (trimmed) treatment groups. Large-bodied turkeys have been selected for maximum performance with trimmed beaks (Noble and Nestor, 1997). Altered beak shape, associated with careful beak trimming is not responsible for reduced intake when feed is provided in the form of mash (Craig et al., 1992).

The feed trough is a major attraction; therefore, the time spent manipulating feed probably reflects the degree of behavioral activation experienced by the hen (Webster and Hurnik, 1992). In some cases, a composite average ingestion behavior of birds in a treatment may mask useful information (Puma et al., 2001). Behavior of individual birds at the feeder, if quantified, could form a comparative basis for assessing alternative management and housing strategies (Gates and Xin, 2001). Two algorithms (AL1 and AL2) were developed to utilize time-series recordings of feeder weights as the bases for assessing individual bird meal activity (Gates and Xin, 2001). Both algorithms were designed to post-process large volumes of weight recordings. AL1 was considered optimally tuned for discerning feeding activity statistics from the high frequency data, and suitable for use in assessing dietary and environment effects on individual birds. AL2 was developed with a different set of criteria than AL1, namely to identify both feeding and non-feeding activities from lower sampling frequency data.

Xin and Ikeguchi (2001, unpublished report) addressed the characterization of feeding behavior of growing broilers by developing a measurement system and analysis method to quantify feeding behavior of individual birds and also characterized the feeding behavior of chickens fed standard ration or sesame-meal diet. The system and methodology used in their study will aid future studies to gain a better understanding of the effects and mechanisms of biophysical factors on poultry feeding behavior and possibly well-being.

In 1965, the Brambell Report concluded that that welfare of animals involves both physical and mental well-being. With respect to the actual well-being of the animal, most issues are centered on how the animal “feels” when managed within a specific level of confinement, during special agricultural practices (e.g. tail docking, beak trimming, etc.) and handling (Swanson, 1995). Three types of definitions of animal welfare are legal, public, and technical and described by Gonyou (1993) as stated in Swanson (1995). Legal definitions are influenced by legislators seeking to establish minimum standards that are accepted by society and can be correctly interpreted by the judicial system. Public definitions are the result of the public’s knowledge, empathy, and activism towards animals. Technical definitions, used by scientists, are based on measurements of well-being. The assessment of well-being should engage scientific evidence available concerning the feelings of the animals that can be derived from their structure and functions and behavior (Brambell, 1965).

Animal agriculture is resisting the efforts of activists that would restrict or destroy the industries and institutions dependent on the traditional uses of animals, according to Singer (CAST, 1997). He also reports that at the federal level, only limited legislation exists related to the humane treatment of animals, and there is none related to animals residing on-farm (CAST, 1997). However, most farmers recognize that deterioration in the welfare of their animals may result in depressions in the productivity and health of individual animals, with potential adverse consequences for profitability (Hemsworth and Coleman, 1998).

Materials and Methods

Equipment

System Set-up

Twenty-seven W-36 White Leghorn laying hens, 14 beak trimmed and 13 untrimmed, were procured from the cooperative company in Iowa. The birds were separated into individual cages the day after they arrived at the Livestock Environment and Animal Physiology (LEAP) Lab II at Iowa State University. The testing and holding rooms selected for this study were environmentally controlled with dimensions of 4.6L x 2.7W x 2.6H m (15L x 9W x 8.5H L ft). Conditions were monitored and recorded every 5 minutes by portable data loggers (HOBO H8 Pro Series RH/Temp. Onset Computer Corp, Pocasset, MA, USA) placed in both rooms and a Campbell Scientific Temperature/RH Probe (Model HMP35C) located in the testing room. The optimal average temperature of 21°C (70°F) and relative humidity in the range of 60-65% were maintained in the rooms. The ventilation system was turned off in the holding and testing rooms to maintain the conditions. Portable lamps provided approximately 10 lux (1.0 fc) of illumination throughout the holding and testing rooms for a 16-hour period (5:00AM to 9:15PM). The intensity of light in the rooms was periodically checked with a digital light meter (model DLM2, Cole Parmer Instrument Co.).

Two types of wire mesh cages were used in the holding room. The first set of cages held 6 birds individually in a 25W x 51D x 38H cm (10W x 20D x 15H in.) space on each of its 3 tiers. The other set of cages, were only one level and held the remaining 9 hens separately with each unit having dimensions of 25W x 46D x 46H cm (10W x 18D x 18H in.). Each hen had her own nipple waterer in the cage. Individual plastic feeders measuring 13L x 13W x 15H cm (5L x 5W x 6L in.) were placed on the outside of the cages for the ease of daily monitoring.

The testing room cage held 4 birds separately in 38W x 46D x 46H cm (15W x 18D x 18H in.) compartments with individual nipple waterers as shown in Figure 1. Aluminum feeders 13L x 15W x 11H cm (5L x 6W x 4.5H in.) with a u-shaped access opening were attached to electronic balances (2200 ± 0.1 g, model GX 2000, A&D Company Limited, Tokyo, Japan) by Velcro® strips as shown in Figure 2.

The balances each had an analog output of 0-2.2 VDC, corresponding to the weighing capacity, which was connected to the electronic data logger (model CR10X, Campbell Scientific Inc., USA). One electronic balance was placed in front of each of the 4 testing cages. The balances have an automatic response adjustment that adapts to vibration and drafts in the environment. The balances were set in continuous comparison mode, which included near zero readings. Balance sample readings were recorded at 1 s intervals. The data were then retrieved to a PC periodically using the PC208W program and the resultant files were saved and backed up once every 24 hours.

Four video cameras (Panasonic, wv-CP410) were used to continuously monitor the bird's duration and frequency at the feeders in the testing room. Two of the cameras were individually focused on the birds occupying cages 1 and 4. The other cameras shared a full picture of neighboring birds in cages (1 and 2) and (3 and 4). The four cameras could be viewed on a color video monitor through the use a Quad System (Panasonic, WJ-420) and were recorded on a Time Lapse Video Cassette Recorder (Panasonic, AG-6730, recording mode of 72hr/tape) as depicted in Figure 3. This assessment methodology is time-consuming, hence costly, tedious and prone to errors (Gates and Xin, 2001). Therefore, the recordings were used for data/algorithm validation purposes only.

Figure 1. Photographical view of the testing room showing four individual cages with a feeder attached to an electronic balance, a temperature/relative humidity probe, and monitoring video cameras.

Figure 2. GX2000 electronic balances with analog output used in the feeding behavior study.

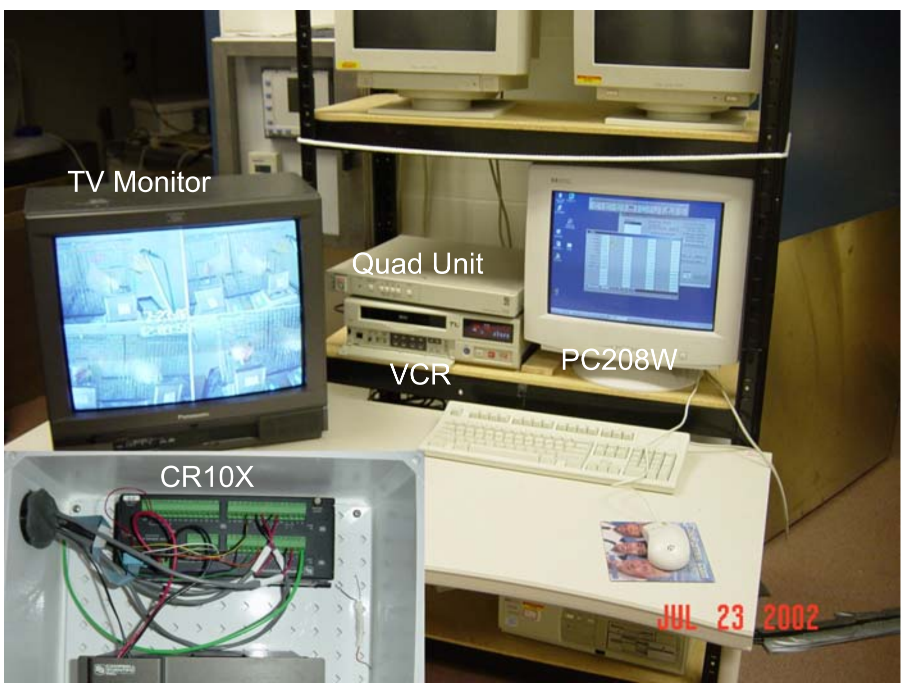

Figure 3. Monitoring and data acquisition system for the feeding behavior study.

Experimental Birds

Hy-line W-36 White Leghorn laying hens, initially 77 weeks of age were used in the study. There were a total of 27 birds of which 13 were untrimmed (NT) and considered the control and the other 14 birds were beak trimmed (BT). The BT birds, processed between 7 and 10 days of age as recommended by Hy-line (2000-2001), were trimmed 2 mm from the nostrils. During the first day in the holding room, body mass was recorded and the birds were labeled with an identification number taped around their legs. Feed consumption was monitored daily in the holding room and the individual feeders were refilled between 10:00-10:50am. Daily egg production was also recorded in both the testing and holding rooms. Commercial diet was used that had the composition of 2895 Cal/kg ME, 15.8% crude protein, 0.82% Lysine, 0.33% Methionine, 4.18% Calcium, 0.315% Phosphorus-AV and 0.176% Sodium.

Two birds of each beak type were randomly selected for a testing sub-group. However, birds consistently consuming significantly less than the total average daily consumption in the holding room were not used in this study. Another hen of the same beak type and similar body mass, which was not previously assigned to a sub-group, was selected as a replacement. Each bird within a sub-group was then given a random testing room cage assignment (1-4). Before the birds were placed in testing room body mass was recorded. Following a 2-day acclimation period, feeding behavior was monitored for the next 72 hours. However, for the purposes of this paper the last 48 hours of each trial were analyzed. Feed was replenished on the first, third and fifth days of the studies. When the trial of a set of birds was completed body mass was again documented before the birds were returned to the holding room. Five sub-groups or 20 hens were utilized in the study. However, for the purposes of this paper data was analyzed from 4 sub-groups or 16 hens.

Analysis of Feeding Characteristics

Ingestion characteristics of the W-36 laying hens and the effects of beak trimming were evaluated using the analysis protocol developed by Xin and Ikeguchi (unpublished report, 2001). Determination of the feeding or meal events was based on a 15-s contiguous stabilized recordings for the BT data and a 20-s stabilization for the NT data. A threshold of 0.5 g was used for determination of a true feeding event for both groups of birds. The stabilization time was selected by trial-and-error optimization so that the daily feed usage values as determined from the algorithm and the manual weighing of the feeders in the beginning and end of the day agreed reasonably well with each other.

Results and Discussion

Histograms were created of the characteristics using the pooled data (more than 2000) for the each beak type. They are denoted as meal size (MS) (fig.4), meal duration (MD) (fig. 5), ingestion rate (IR) (fig. 6) and meal interval (MI) (fig.7), respectively. The non-trimmed (NT) and beak trimmed (BT) birds shared similar MS. Approximately 70% of the hen-feeding activities had a MS of 0.7 g or less, as displayed in Figure 1. MD for the birds differed, as shown in Figure 2, in that 70% of the NT hen-feeding showed 80 s/meal whereas and the same percentage of BT hen-feeding took approximately 32-s longer to complete the same MS. Notably in Figure 3 NT birds had an IR of 1.3 g/min as compared with BT birds that had a slower IR of 0.9 g/min. The BT birds also ate more frequently than the NT birds. Figure 4 demonstrates that 70% of the BT hen-feeding had an average MI of 200 s (or slightly over 3 min) while the NT birds had an average MI of 450 s (7.5 min).

A scatter plot of MD vs. MS for the two types of birds is shown in Figure 8. A regression equation for each beak type as well as the combination of the two types is displayed. The R^2

value(s) is not very high; however, this equation(s) provides a general estimation of the time required for the bird to take in a certain amount of feed. For the purposes of this paper statistical analyses were not performed. However, the analyses will be needed for more informative future results.

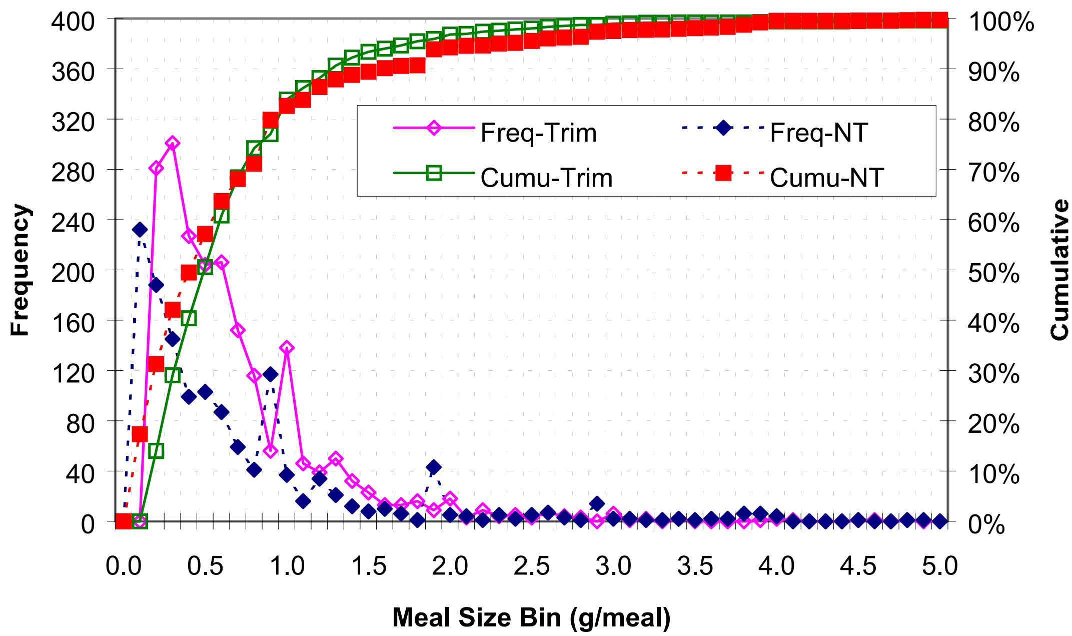

Figure 4. Distribution of meal size (MS) of 16 laying hens with a trimmed or non-trimmed beak.

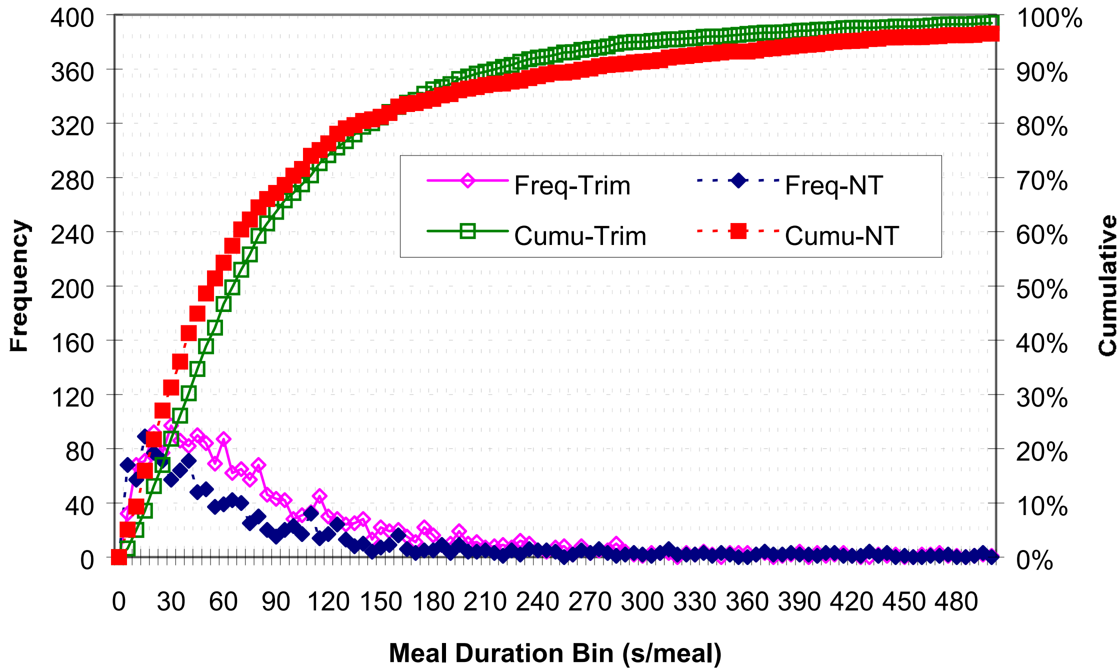

Figure 5. Distribution of meal duration (MD) of 16 laying hens with a trimmed or non-trimmed beak.

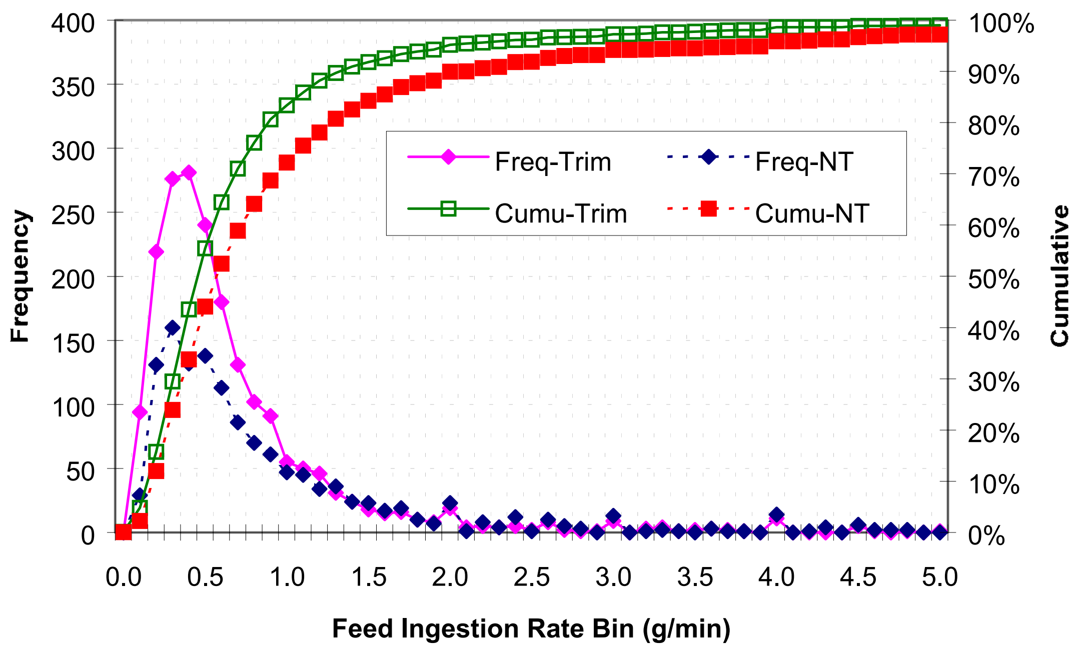

Figure 6. Distribution of feed ingestion rate (IR) of 16 laying hens with a trimmed or non-trimmed beak.

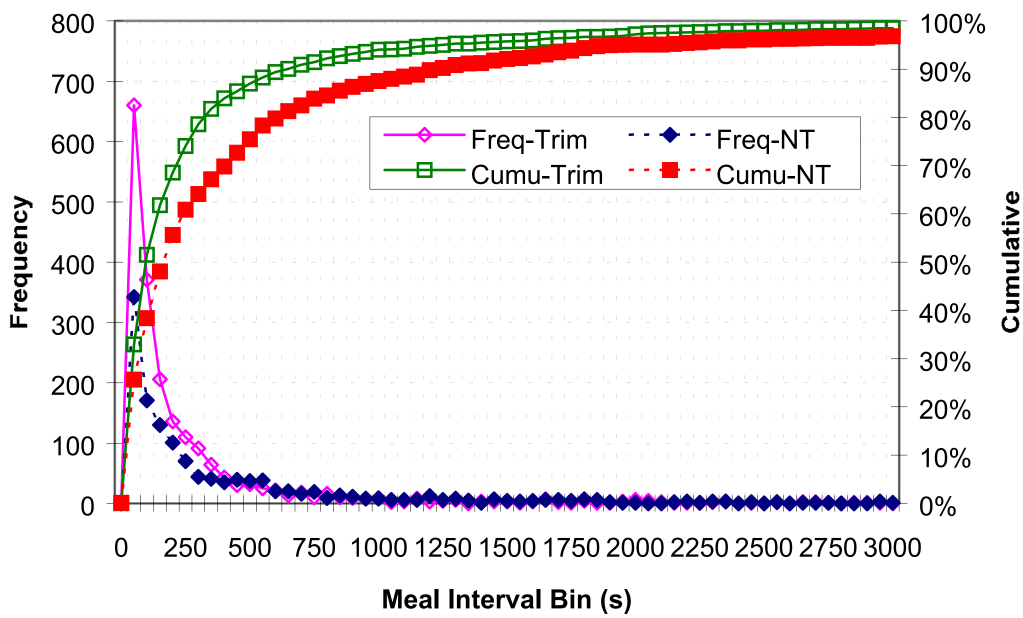

Figure 7. Distribution of meal interval (MI) of 16 laying hens with a trimmed or non-trimmed beak.

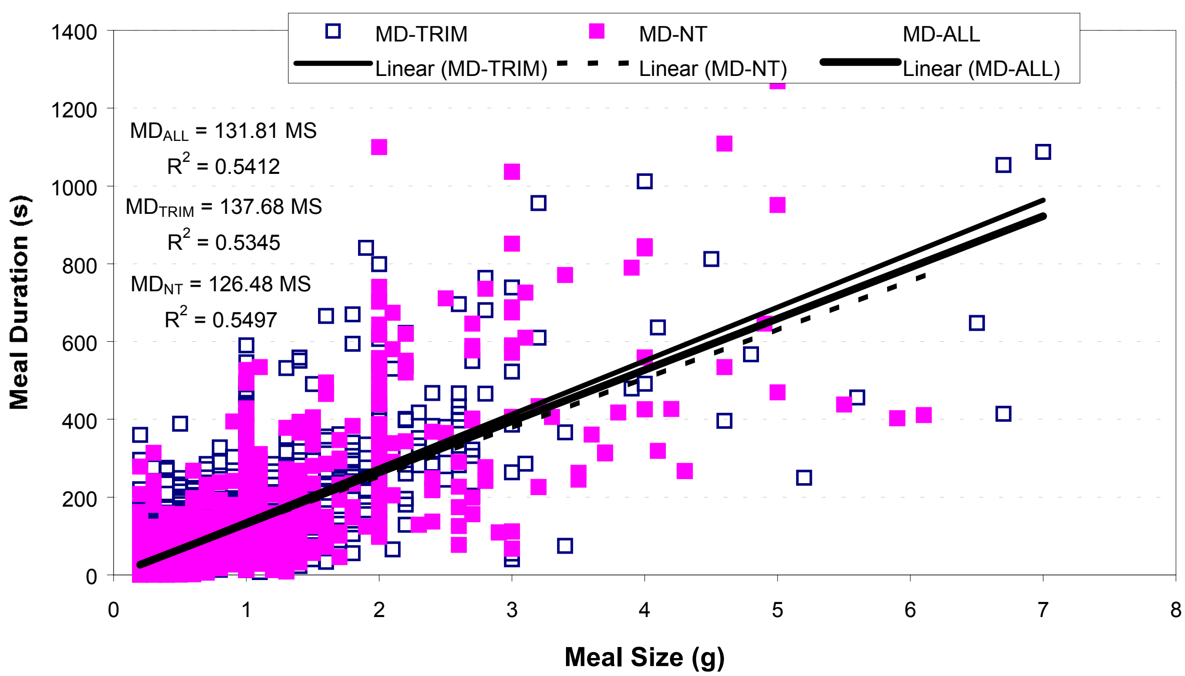

Figure 8. Relationships of meal duration (MD) to meal size (MS) of 16 laying hens with a trimmed or non-trimmed beak.

Conclusions

The issue of how to quantify animal welfare continues to be a challenge for the academic community and the animal industry alike. Compilation of fundamental behavioral data may provide scientific basis for management practices to possibly improve the welfare of animals. The following conclusions were drawn from the current study.

Some baseline data on feeding characteristics were collected and analyzed for non-trimmed (NT) and beak trimmed (BT) laying hens. Both NT and BT hens showed similar meal size. BT birds tended to spend longer time at the feeder, which is compatible to their slower ingestion rate of 0.9 g/min vs. 1.3 g/min for the NT hen. Compared with NT bird, the BT bird had smaller time intervals between meals (200 vs. 450 s). More data of this nature is needed to better understand and quantify the potential impacts of management practices on bird welfare.

Acknowledgements

We would like to extend our gratitude to Dr. James Arthur of Hy-line International for making arrangements in procuring the experimental hens. We would also like to thank Rose Acre Farm for supplying the hens and feed. Funding for this research was provided in part by the Multi-state Regional Research Project NE-127 "Biophysical models for Poultry Production Systems".

References

Brambell, F. W. R. 1965. Report of Technicka Committee to enquire into the welfare of animals kept under intensive husbandry systems. Command Paper 2836. HM Stationery Office, London, United Kingdom.

Christensen, K. 1984. Beak trimming: a review of procedures. Poult. Digest (Sept.): 374-375.

Christmas R. B. 1993. The performance of spring- and summer-reared broilers as affected by precision beak trimming at seven days of age. Poult. Sci. v. 72(Dec.): 2358-2360.

Clough, C. E., Kew, B. 1993. Animal production. In *The Animal Welfare Handbook*, 44-55. London: Fourth Estate Limited.

Council for Agricultural Science and Technology. 1997. The well-being of agricultural animals. CAST, Ames, IA.

Craig J. V., W. S. M. Winkler and G. A. Milliken. 1992. Effects of beak trimming and genetic stock of rate of mash consumption and feeding-related behavior in egg-strain pullets. Poult. Sci. v. 71(Nov.):1959-62.

Cunningham, D. L. 1992. Beak trimming effects on performance, behavior and welfare of chickens: a review., J. Appl. Poult. Res. 1:129-134.

Deaton J. W., B. D. Lott and J. D. May. 1998. Effect of beak trimming on body weight and feed intake of broiler roaster fed pellets or mash. Poult. Sci. v. 67(Nov): 1514-17.

Dunayer, J. 2001.Feeding on flesh, milk, eggs, and lies. In *Animal Equality*, 125-147. Derwood, Maryland: Ryce Publishing.

Duncan, I. J. H. 1992. Measuring preferences and the strength of preferences. Poult. Sci. v. 71(Apr.): 658-663.

Dutch Society for the Protection of Animals. 1996. The vulnerability of poultry. In *The Vulnerable Animal in IntensiveLlivestock Farming*, 86-87. The Hague, Netherlands: Dutch Society for the Protection of Animals.

Gates, R.S. and H. Xin. 2001. Comparative analysis of measurement techniques of feeding behavior of individual poultry. ASAE Paper No. 01-4033. Sacramento, CA.: ASAE

Gentle, M. J., D. Waddington, L. N Hunter, and R. B. Jones. 1990. Behavioural evidence for persistent pain following partial beak amutation in chickens., Appl. Anim. Behav. Sci. 27:149-157.

Gomes W. R. 1993. Future impact of new science and emerging technologies on animal well-being. In Proc. Food Animal Well-Being Conference and Workshop, 89-97. Indianapolis, IN., 13-15 April.

Hensworth, P.H., G.J. Coleman. 1998. Human-Livestock interactions: The ethics of animal farming. In *The Stockperson and the Productivity and Welfare of Intensively Farmed Animals*. Ch. 2, 19-39. New York, New York: CAB International.

Hy-line International. 2001. Variety W-36 Commercial management guide. Hy-line International, West Des Moines, IA.

Lee, H. Y. and J. V. Craig. 1991. Beak trimming effects of bejavior patterns, fearfulness, feathering, and mortality among three stocks of white leghorn pullets in cages or floor pens. Poult. Sci. v. 70(Feb): 211-221.

Noble, D. O. and K. E. Nestor 1997. Beak trimming of turkeys. 2. Effects of arc beak trimming on weight gain, feed intake, feed wastage and feed conversion. Poult. Sci. v. 76 (May): 668-70.

Puma, M. C., H. Xin, R. S. Gates and D. J. Burnham. 2001. An instrumentation system for studying feeding and drinking of individual poultry. Applied Engineering in Agriculture. v. 17(3): 365-374.

Struwe, F. J., E. W. Gleaves, and J. H. Douglas. 1992. Stress measurements on beak-trimmed and untrimmed pullets. Poult. Sci. v. 71:1154-1162.

Swanson. J. C. 1995**.** Farm Animal Well-being and Intensive Production systems. J. Anim. Sci. v. 73:2744-2751.; 60 ref.

Webster, A. B. and J. F. Hurnik. 1991. Breeding and Genetics: Behavior, production, and well-being of the laying hen. 2. Individual variation and relationships of behavior to production and physical condition. Poult. Sci. v 70(Mar.): 421-428.

Xin, H. and A. Ikeguchi. 2001. Characterization of feeding behavior of growing broilers. Iowa State University, Ames, Iowa, USA.